

Decarbonatization package for long-haul truck transport by bundling electrification, high-capacity transport, and digitalization concepts

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Agenda

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2. Electrification of long-haul truck transport
3. High-Capacity Transport
4. Bundle Electrification, High-Capacity Transport, and Digitalization
5. Ideas for further research
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1. Summary

- **Electrification** of long-haul truck transport **requires large subsidies** of vehicles, batteries/fuel cells, and energy stations.
- **High-capacity vehicles decrease transport cost with 15-30%**. Cost of adjusting the infrastructure is relatively small. Policy makers are concerned that productivity improvement lower price for road transport and by that reduces the market share of rail and sea transport.
- By **mandating** that **High-capacity vehicles** must be **zero emission vehicles** the operators can use the **savings cost** to **pay** for the extra cost of **electrification** instead of getting subsidies.
- The extra earning kept by the operator should preferable be combined with **other policy instruments e.g. a fee/tax** based on vehicle*km, lane space/payload, or CO2/ton*km. The parameters should be changed over time to adjust for the impact of technical development, policy goals and context.
- The **fee could be used for** e.g. compensating for less fuel taxes or speeding up: deployment of charging infrastructure, adapting the roads for HCV, or shift from road to sea and rail.
- **Both Electrification and High -apacity vehicles reforms require**
 - **Digital** Framework to connect all components
 - **Legal and Institutional** Framework for all the above
- **Further research**
 - Remove barriers for Electromobility, HCV and Digitalization.
 - Promote innovations to speed up Electrification
 - Integrate with adjacent systems
 - System analyses



2. Electrification of long-haul truck transport

- **Requires**

- **Infrastructure** for energy supply with charging stations for electricity or hydrogen
- **Vehicles** with electrical motors and energy packages with batteries or fuel cells with hydrogen tank
- **Digital Framework** to connect all components for planning and operation of vehicles, logistics, and charging
- **Legal and Institutional Framework** for all the above

- **Cost**

- With current policies the total cost of ownership for electrical trucks are expected to be **equal** to trucks with **combustion engines in 2-5 years**.
- **Energy per ton*km** or **kWh*km** decreases with the size of the vehicle. Relation **battery weight/payload** also **decreases**. Cost of ownership is also expected to decrease if the distance between charging is the same.
- **Charging on route is required** since charging at depot or at loading/unloading places not sufficient

- **Time for deployment**

- Most OEMs predict that half of sold trucks will be electric by 2030 and stop producing combustion engines by 2045
- Some nations plan to ban sales of cars with combustion engines by 2025 and ban sales of fossil fuels by 2030. Unclear if trucks are included
- Some cities are already banning combustion engines in dedicated zones
- **Need for large subsidies** for buying electrical trucks and for building infrastructure for energy supply if such fast deployment is desired

- **Side effects**

- **Less noise and harmful emissions**



3.1 Drivers, Barriers, Casual Relations of HCT

Drivers	Causal relations
Productivity, Cost	Less drivers, trucks, energy consumption per ton*km
Road wear, Bridge life	More axels & No overloads -> Lower axel loads
Accidents	Less traffic->less fronts Stricter truck standard + Better rule compliance
Traffic, Lane space	More load -> fewer trips -> less traffic
Climate, Emissions	Less energy/ton*km -> less CO2 or smaller batteries or longer range
Barriers	
Rebound, More transport, Modal split	Lower cost-> Lower prices->More road-> Less Rail & Sea-> More CO2
Cost for road owner	Strengthen bridges + Length of lanes
Impact of non-compliance	Road wear + Accidents + Not in my backyard

3.2 The High-Capacity Transport Concept

Definition: Vehicles that are longer or heavier than currently allowed for general access to use each road section to its maximum capacity without increasing road damage.

- **Requires**
 - **Roads** adapted for specific High Capacity Vehicles
 - **Vehicle** with performance specifications for specific roads
 - **Operating requirements** for driving these vehicles on the specific roads. **Access and Compliance Assurance Schemes**
 - **Digital Framework** to connect all components
 - **Legal and Institutional Framework** for all the above
- **Cost/benefit**
 - **Cost** (energy, driver, vehicle, service) per ton*km or kbm*km **decreases with the size** of the vehicle. Revenues for operator increases.
 - With current policies the total **cost for transport per ton*km or kbm*km is 15-30% less** for HCV than for current vehicle configuration
 - **Cost to adapt the roads** is very **low** for longer vehicles (cost/benefit = 1/13) and moderate for heavier vehicles (cost/benefit = 1/8)
 - **Cost for Digital Framework** is **low** since using already installed fleet management systems
- **Time for deployment**
 - Most of **current vehicles and trailers** can be used with **slight modifications**. If longer vehicles, the middle trailer must be reinforced, and a dolly must be added to attach the second semitrailer. If heavier vehicles, extra axles must be added to comply with the maximum allowed axel load.
 - For longer vehicles, increase the length of turning lanes and parking areas takes some months. For heavier vehicles, inspect, upgrade, and in some cases, reinforce bridges.
 - Finland increased from max 60 to 76 ton 2013 and from 25.25 to 34.5 m 2019 on all roads if not otherwise signed. Other countries only allow specific HCV on dedicated roads.
- **Side effects**
 - **Less need for road space, congestion, capacity investment; Less energy, climate impact, harmful emission; fewer accidents**
 - **Lower transport cost -> lower price for road transport->modal shift from rail/sea to road.** Not politically desired. **Requires intervention** to maintain desired modal split, e.g. a fee/tax



3.3 Access Schemes for HCV

- A. New road class:** A limited dedicated road network for a specific class of HCV
- B. Permanent permit:** PBS certified vehicles from a mine
- C. Time limited permit:** Temporary construction site, forest harvesting every 50 years
- D. Situation adapted permanent permit or restriction:** More loads when frozen, shift from diesel to electric power train when entering an environmental zone or at night
- E. Permit for one specific trip:** Non-divisible goods, heavy mobile cranes

3.4 Compliance Assurance Schemes for trucks

1. **Self-regulation** of operators: RTMS for PBS permits in South Africa.
2. **Traditional** monitoring: Fixed stations, Weigh In Motion, roadside inspections
3. **Driver support** & warning: In cabin, geofencing
4. **Report without IDs** position and weight data: RIM Australia, VELUB Estonia, ITK-statistics Sweden
5. **Report with IDs** position and weight data: TMA in Australia, tachograph audits in EU, ITK1.0 in Sweden
6. **Independent certification** of the whole IA system: 100% non-compliance reporting as IAP in Australia
7. **Speed is reduced**, or forcing a vehicle to stop: Geofencing, entering a pedestrian zone or a vulnerable bridge



3.5 Combining Access and Compliance Assurance

Access	A	B	C	D	E
Compliance					
1		a			
2					
3					
4			b		
5					
6					
7					c

- a. PBS (B) permits in South Africa requires RTMS (#1)
- b. Temporal permit (C) to take more loads when moving earth and rocks when building the subway under Sydney in Australia requires RIM (#4)
- c. Stopping a mobile crane (#7) trying to enter a vulnerable bridge (E)



4. Bundle Electrification, HCT, and Digitalization in the same reform package

- **HCT** reduces energy consumption with 8-50% for individual vehicles.
 - **Reduces battery size by 8-50%** if electric and CO2 if combustion engine
- **Use the cost savings from HCT to:**
 - Let the **operator** keep part of the savings to **compensate** for the initially **higher purchasing price** of electric trucks to speeds up the shift
 - Invest in **energy infrastructure**, e.g. charging or hydrogen stations in corridors
 - Reimburse **road owners for adopting to HCT**, e.g. longer turning lanes and parking places
 - Compensate the **government for less fuel taxes**
 - Subsidize **shift** from road **to rail and sea** transport
- **Digital Framework:** connect planning and operation of vehicles, logistics, traffic, and charging
- **Legal and Institutional Framework** for all the above
- **Pilots** to fine tune technology/policy and convince stakeholders
 - **DUO-trailer** between terminals/dry port. Shunting trailers at city borders and corridor intersections



5. Ideas for further research

- **Remove barriers for Electromobility, HCV and Digitalization.**
 - Better understand **drivers and barriers** for all stakeholders. Design policies to remove barriers
- **Promote innovations to speed up Electrification**
 - **Removable energy packages** (batteries, super capacitors, fuel cells, hydrogen tank). On prime mover, dolly or trailer. Swop instead of charging. Choose package for the trip. Change when technology improves. New business model where a player provides both energy packages and energy charging infrastructure.
 - **Engines distributed** among the vehicle modules. Electric engine could be placed in prime mover, trailers, link, dolly, individual axel. The EU-project Aeroflex did develop this including a control system. A current prime mover with a combustion engine can hence be combined with one or several electric engines/generators to form a hybrid power system.
 - **Converting** current prime mover by replacing the combustion engine with an electric engine, axel or wheel.
 - **Leapfrog** directly to electromobility without first using combustion engines and fossil fuel infrastructure by building road, electricity, and digital infrastructure simultaneously, e.g. in developing and fast-growing economies.
- **Integrate with adjacent systems**
 - **Operations** before/after transport: terminals, unit loads, inventory, production
 - Other **transport mods**: parallel, sequential, manage uncertainties, A-modal operators
 - **Transport of persons**: road space access, combined vehicles

System analyses including cost-benefit analyses for a verity of scenarios combining deployment strategies, technologies, and backgrounds 40 y. ahead, e.g. for a low carbon corridor or a larger geographic area.



6. Conclusions

- **HCT deployment can start within 1 year**
- **The productivity increase of HCV for long-haul could pay for**
 - **Electrification and Digitalization**
 - Promoting **multimodal** transport
 - Improve **roads**
- The **charging infrastructure for HCV** could then be used **for all other electrical vehicles**
 - **Current strategy is the opposite:** first smaller and last the largest vehicles
- **Most road vehicles may be electric by 2030 instead of 2045**
- **All parts necessary for success:** Roads, Vehicles, Power train, Energy module, Charging infrastructure, Intelligent access, Compliance assurance, Digital framework, Legal and Institutional
- **Drivers and barriers** must be identified and removed.
 - Bring in legal, other trsp. modes, police, and policy makers from beginning
 - Bundle road & rail in amodal services, optimize risk sharing, liftable trailers
 - Winners pay losing stakeholders for their extra cost
- **Promote** further innovation and research to **speed up Electrification, e.g. converting, hybrid, leapfrogging**

